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Economic impact of the Spruce Budworm outbreak in Newfoundland

G. R. Milne

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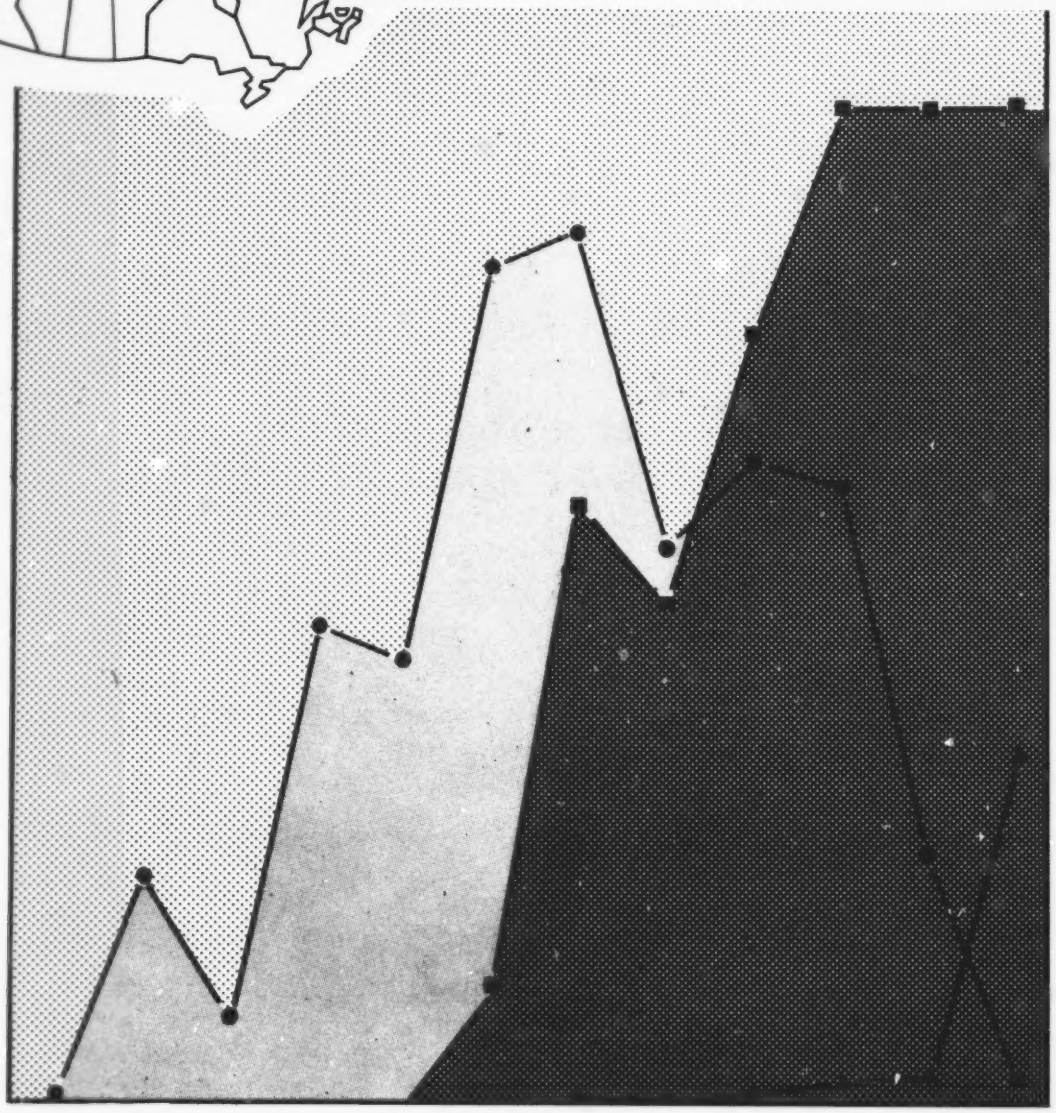

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ECONOMIC IMPACT OF THE SPRUCE BUDWORM OUTBREAK IN NEWFOUNDLAND

by G.R. Milne

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CANADIAN FORESTRY SERVICE

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ABSTRACT

The forest resource and dependent industries are a major to 1983, 484 300 hectares of productive forest, containing a merchantable softwood volume of 51 million m^3 were damaged by the spruce budworm. During this period, the estimated economic costs associated with the budworm outbreak were $65.0 million in 1983 dollars. Estimated costs of continued salvage logging to 1988 are $23.0 million in 1983 dollars. Expenditures on intensive management programs to increase future wood supplies were $46.8 million during 1972 to 1983. The present value cost in 1983 dollars of rehabilitating the remaining damaged stands could reach $140 million. The long-term impact of the outbreak on wood supplies and the forest environment are difficult to quantify. More research is required.

RÉSUMÉ

Une source importante d'emplois et de revenus pour l'économie de Terre-Neuve se trouve dans les ressources forestières et les industries connexes. De 1972 à 1983, 484 300 ha de forêts de production, représentant un volume de 51 millions de m^3 de bois blanc, ont été endommagés par la tordeuse des bourgeons de l'épinette. Durant cette période, on a estimé la perte économique associée à l'épidémie de tordeuse des bourgeons de l'épinette à 65 mil. de dollars 1983. La prévision des coûts de récupération du bois jusqu'en 1988 s'élève à 23 millions de dollars 1983. De 1972 à 1983, on a estimé à 46.8 millions de dollars les dépenses encourues pour l'application de programmes de gestion intensive visant à augmenter les provisions futures de bois. Le coût actuel en dollars 1983, qui est prévu pour rétablir les zones de bois encore endommagé, pourrait s'élever à 140 millions. Il est difficile de quantifier les conséquences à long terme de l'infestation sur les provisions de bois et l'environnement forestier. Il faut continuer les recherches.

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ECONOMIC IMPACT OF THE SPRUCE BUDWORM OUTBREAK IN NEWFOUNDLAND

by

G.R. Milne

1.0 INTRODUCTION

Newfoundland's forest stocks are an important component of the Provincial resource base, providing a variety of economic benefits to both public and private interests. These benefits include wood fibre used for the manufacture of products such as lumber and newsprint. The forests also provide a source of wood energy for many rural Newfoundlanders. The non-market values of forests are equally important. Access to forest areas for recreation, hunting, fishing and trapping is highly desired by many individuals. Often overlooked are the ecological or environmental benefits of forests which include protection of soil and water resources, and maintenance of habitat for plants, fish and wildlife. Forest resources are renewable if properly managed. Therefore, the socio-economic, aesthetic and ecological benefits derived from Newfoundland's forests can potentially be supplied in perpetuity.

Over a period of one rotation, or approximately 50 to 60 years, the supply of timber is variable and can be greatly influenced by management practices. Increased use of treatments such as planting, thinning and fertilization can expand the future forest stock to a considerable degree. Therefore, in the long run, the potential exists to increase the flow of benefits from Newfoundland's forests.

In the short-term, however, the stock of forest resources is relatively fixed. The supply of timber and non-timber outputs depends largely upon the rate at which the existing stocks are depleted (Lyon and Sedjo, 1983). Depleting forest stocks under a policy of sustained yield will generally allow an even flow of benefits over time. Major depletions from natural causes such as fire, insects and disease can drastically reduce the short to intermediate supply of timber. A resulting impact may be short-term timber deficits, environmental degradation and loss of aesthetic values.

The present spruce budworm outbreak on the Island portion of Newfoundland began in 1972 and has had a major impact on the forest resource. By 1980, the area of severe infestation exceeded more than one million ha (Poole et al., 1981). While the actual timber losses from the spruce budworm have been estimated to 1983, the economic impact of these depletions requires updating. The most recent economic assessment of spruce budworm damaged in Newfoundland occurred in 1980 (Munro, 1981) as part of the Canadian Forestry Service submission to the Royal Commission on Forest Protection and Management. The study viewed the problem on a Provincial basis. This approach, while expedient, can mask the more important regional impacts due to budworm damage (Baskerville, 1983).

This present study has three major objectives. First, the Island's forest land base and forest industry will be described in detail. The importance of the industry to the provincial economy and wood requirements to the year 2040 will also be presented.

The second objective is to assess short-term economic impacts stemming from budworm losses up to year 1983. These impacts will be presented on a broad provincial basis.

The third major objective is to discuss potential long-term impacts of the current budworm outbreak. Where possible, these impacts will be described on a regional basis.

This study should provide useful information to assist government and industry in making future policy decisions affecting the Newfoundland forest resource. Examples could include policies on intensive management, utilization standards, chemical protection and long-term planning.

2.0 THE FOREST RESOURCE AND FOREST INDUSTRY

2.1 Forest Resources on the Island

Of the more than 11 million ha of total land base area on the island of Newfoundland, 6.2 million ha are forested (Table 1).

Table 1. Land base for the island of Newfoundland.[1]

Land class		Area (1 000 ha)	% Total
A.	Forest Area		
	1) Productive forest	3 786.2	34.0
	2) Non-productive forest	2 443.6	21.9
	Sub-total	6 229.8	55.9
B.	Water	1 126.0	10.1
C.	Non-Forested		
	1) Soil barren	1 729.0	15.5
	2) Rock barren	375.7	3.4
	3) Bog	1 595.3	14.3
	4) Cleared land	82.5	0.7
	5) Agricultural land	6.3	0.1
	Sub-total	3 788.8	34.0
Total Land Base		11 144.6	100.0

[1]Source: Dept. of Forest Resources and Lands 1980. Brief to the Newfoundland and Labrador Royal Commission on Forest Protection and Management.

The 3.8 million ha of productive forest area refers to lands capable of yielding a timber stand of at least 35 m^3 per ha at rotation age. These areas, while distributed throughout the Island, are concentrated in western and central regions (Figure 1). Softwood stands (75% to 100% softwood) comprise 74% of the productive forest area. The softwood resource is dominated by two species, black spruce (Picea mariana (Mill.) B.S.P.) and balsam fir (Abies balsamea (L.) Mill.). Black spruce is most common in eastern and east-central productive forest areas, while balsam fir is more prevalent in western, west-central and northern areas.

The gross merchantable softwood volume on the Island using 1979 inventory volume is approximately 174 million m^3. This figure refers to the volume of live softwoods on all slopes and includes cull. A more realistic net inventory estimate of 127 million m^3 is calculated by deducting stands on steep slopes (> 30%) and including stands only with merchantable volumes of 60 m^3 per ha or greater. This inventory volume must be viewed with caution. In the period 1979 to 1984, the structure of the forest resource has changed through harvesting, budworm losses, fire and in-growth. Not all of these changes have been updated into the Provincial inventory base. Therefore, the 1979 inventory figures only provide an estimate of standing softwood volumes.

The most recent published data on annual allowable cuts (AAC) in Newfoundland are found in the Royal Commission Report (Poole et al., 1981). The Commission presented softwood AAC projections to the year 2040. Assuming a comprehensive insect protection plan was con- tinued as necessary, the softwood AAC was forecast to remain in the 3.0 million m^3 range, with slight fluctuations over time. This forecast was made using Provincial inventory data prior to 1980. The forecast must be viewed with caution for several reasons. First, the inventory data include stands on all slopes and do not recognize economic accessibility. Second, recent damage in spruce stands may reduce the AAC figures. Third, the forecast does not incorporate the effects of past, present and future intensive management programs. These factors tend to offset one another, that is, some factors tend to increase AAC while others act in the opposite direction. The net direction, scope and timing of changes to the long-term softwood AAC cannot be determined at this time. Therefore, the AAC figures of 3.0 million m^3 must be used in this report while recognizing its limitations.

Figure 1. Productive forest area, Newfoundland and Labrador.

2.2 The Forest Industry

The Newfoundland forest resource supports a primary and manufacturing industry which makes an important contribution to the provincial economy. Principal statistics for 1981 are shown in Table 2.

Table 2. Principal statistics of the Newfoundland forest industry, 1981.

Forest industry	Number of establishments	Total sector employment (person-years)	(x $1,000) Total wages & salaries	Value of shipments	Value added
Logging[1]	23	1,580	33,154	89,422	52,324
Sawmills and Planing Mills[2]	1,741	1,356	5,237	8,809	3,518
Other wood Industries[3]	92	521	9,442	33,768	20,754
Pulp & Paper[1]	3	2,981	90,208	353,000	194,049
Total	1,859	6,438	138,141	484,999	270,645

[1]Source: Statistics Canada, 25-202 Annual.

[2]Source: Milne, 1984.

[3]Source: Milne and Mallay, 1984.

Applying employment and income multipliers suggests the Newfoundland forest industry generates an additional 10,000 person-years of employment and $61 million in wages and salaries throughout other sectors of the economy. These indirect impacts appear to be strongest in the petroleum, service and supply industries, given their well defined forward and backward linkages with forestry.

In a broad Provincial context, the forest industry is among the largest industrial sectors (Table 3).

Table 3. Forest industry's contribution to the Newfoundland economy, 1981.

Provincial industry sector	Forest Industry's Share (%)			
	Employment	Income	Value of shipments	Value added
Primary	4.2	14.6	7.0	7.0
Manufacturing	23.2	26.1	28.7	36.7

The contribution of forestry manufacturing is quite significant and indicates the relative importance of the sector to the Provincial economy. An additional contribution is the generation of public revenues. Following methods used in a previous study (Milne, 1981), tax revenues paid to Federal and Provincial treasuries in 1981 were an estimated $27.3 million and $43.1 million respectively. Further, the Province collected approximately $520,000 in forestry fees such as permits, licenses and stumpage.

Since 1981, there have been significant reductions in capacity and employment in the pulp and paper sector. In 1983, the newsprint mills in Corner Brook and Grand Falls reduced capacity by 110 000 tonnes and permanent employment by approximately 800 person-years. Therefore, the forest industry's contribution to the Provincial economy may be less than indicated in Table 3. The industry is still a major economic force, especially in terms of employment. The average annual unemployment rate in Newfoundland over the period 1979 to 1983 was 15.6%. Unofficial unemployment rates in specific areas have ranged as high as 60 or 70%. In many rural regions of the Province, where alternative employment and resource development opportunities are limited, forestry may be the primary source of employment.

3.0 STATUS OF BUDWORM DAMAGE

3.1 Historical Background

Spruce budworm outbreaks have been occurring in eastern Canada for well over 200 years from analysis of ring-growth in old white

spruce (Blais et al., 1981). The most recent outbreak began in 1972 and rapidly spread throughout the forested areas of the Province. Factors which contributed to the severity of the outbreak included considerable moth dispersal from the mainland, favourable weather on the Island and an extensive food supply of mature balsam fir.

3.2 Extent of Spruce Budworm Damage

For the period 1972 to 1983, approximately 484 400 ha of merchantable softwood stands have been damaged by the spruce budworm (Raske et al. 1986). Out of a total stand volume of 50 763 000 m^3, more than 23.1 million m^3 are dead and 2.9 million m^3 are dying (Table 4).

Table 4. Cumulative area and volume of damage in predominantly balsam fir and black spruce stands, Newfoundland, 1972 to 1983.[1]

Tree species	Total area (ha)	Dead volume (m^3)	Dying volume (m^3)	Total stand volume (m^3)
Balsam fir	388 700	19 905 000	1 984 000	40 441 000
Black spruce	95 700	3 194 000	915 000	10 322 000
Total	484 400	23 099 000	2 899 000	50 763 000

[1]Source: Appendix A

Over the ten year period, a proportion of the damaged fibre has been salvaged, burned and blowndown. These depletions have also occurred for undamaged trees in the total stand area. One should recognize that damaged trees are distributed among the live, healthy trees. Therefore, a salvage operation for example, will remove both healthy and damaged trees as a particular stand is harvested.

Up to 1983, approximately 5.6 million m^3 of timber were salvaged from damaged stands of which 62% were in dead and dying condition. For the same period, 562 000 m^3 were burned, of which 56% were dead and dying. Also, 6.4 million m^3 of timber were lost through blowndown, of which 100% were in the dead and dying categories. The net result of these depletions is that a total of 38.2 million m^3 of timber remain on the original damaged

area of 484 300 ha. Approximately 17.9 million m^3, or 47% of the remaining volume is in the dead and dying classes. The 38.2 million m^3 represents the maximum volume available for salvage. An estimated 34.9 million m^3 of this volume is actually salvageable given access and terrain constraints. Realistically, only a small percentage of this fibre will likely be salvaged prior to deterioration given constraints of accessibility, economics of harvesting damaged stands, and actual industry wood requirements (Raske and Sutton, 1982).

In terms of species, approximately 82% of the area damaged contains predominantly balsam fir stands, while 18% is mostly black spruce (Hudak et al., 1983). On the basis of volume, 89% of damaged stands are balsam fir and 11% black spruce.

4.0 LONG-TERM SOFTWOOD FIBRE REQUIREMENTS

4.1 Background

The 1980 Royal Commission on Forest Protection and Management (Poole et al., 1981) estimated current wood consumption, with forecasts to the year 2020. These projections were developed using the best available information. However, in the past four years, improved data have become available, therefore, new estimates can be made.

No model currently exists which can accurately predict how the future will unfold. Projections of long-term softwood requirements involve making general assumptions about changing consumption patterns, new technologies in processing, trends in plant efficiency and product markets to name but a few. The uncertainty inherent in predicting future softwood requirements suggests that resulting values are only guides as to what "might" happen 50 or 60 years hence. To acknowledge this implicit error, a sensitivity analysis should be conducted whereby many of the initial assumptions are adjusted. An appropriate technique is to vary the assumption to provide a range of possible future outcomes. This technique can produce maximum and minimum values as outside parameters of the long-term estimates. The expected future value can be assumed to fall somewhere in between the outside parameters with a high degree of probability.

4.2 Current Consumption and Forecasting Assumptions[1]

This chapter uses three scenarios to provide a range in possible long-term softwood requirements. The first scenario assumes an optimistic

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[1]Note - In the following sections, all wood volumes are in solid m^3, not stacked m^3.

outlook, with strong markets, improved mill efficiency and high annual growth in wood requirement. A second scenario assumes a pessimistic outlook, with weak markets, deteriorating mill efficiency and low annual growth in wood requirements. A third scenario is a more moderate outlook, with assumptions falling between the optimistic and pessimistic projections. The assumptions used in each scenario are provided by a consumption sector, in the following three pages.

4.21 Sawmills and planing mills

Current softwood requirements are approximately 192 600 m^3 to support domestic lumber production of 96 000 m^3 (Milne, 1984). The volume of domestic lumber production cannot be increased appreciably over the short and medium term. Spruce budworm damage over most of the Island's forest and lack of cutting control on unalienated Crown lands in certain regions, have contributed to tight sawlog supplies. In addition, the current tenure structure with the two older paper mills has prevented greater access to sawlogs in the interior forest regions. Over the short to medium time horizon (less than one rotation), sawlog supplies could be increased to a limited degree through improved access on unalienated Crown lands and stand improvement programs.

Estimated annual increases in softwood sawlog consumption to the year 2040 are:

a)	Optimistic outlook	1.80% annual increase
b)	Moderate outlook	0.90% annual increase
c)	Pessimistic outlook	0.0% annual increase

Past data indicate 76% of sawlogs will be harvested from unalienated Crown lands and 24% from small private holdings.

4.22 Domestic and industrial fuelwood

In 1983, approximately 597 000 m^3 of softwoods were harvested for domestic fuelwood (Northland Associates, 1984). This volume is more than twice the amount burned in 1979. The rapid expansion of wood as a fuel source reflects major increases in the cost of electricity and oil alternatives. Over the next rotation period, this rate of increase in fuelwood consumption should moderate for two reasons. First, costs for electricity and oil may not increase as rapidly as in the past, and second, growing scarcity of easily accessible fuelwood in some regions may preclude its use as an energy source.

Estimated annual increases in domestic fuelwood consumption to the year 2040 are:

a)	Optimistic outlook	1.00% annual increase
b)	Moderate outlook	0.50% annual increase
c)	Pessimistic outlook	0.25% annual increase

Past data indicate 78% of domestic fuelwood is cut from unalienated Crown land, 13% from private holdings, and 9% from paper company limits.

The use of industrial fuelwood has gradually expanded over the past five years and there is a large potential for future increases in consumption. The use of industrial fuelwood should not be a drain on standing commercial softwood volumes since this fibre can be obtained from hardwood stands, logging residues, sawmill wastes and non-commercial softwoods.

4.23 Miscellaneous softwoods

Miscellaneous softwood requirements include timber for agricultural, mining and marine uses. Estimated consumption in 1983 was 48 000 m^3. The demand for this timber should not increase significantly over the next rotation period. Estimates of annual growth in consumption to the year 2040 are:

a)	Optimistic outlook	0.50% annual growth
b)	Moderate outlook	0.25% annual growth
c)	Pessimistic outlook	0.10% annual growth

All miscellaneous softwood fibre is assumed to be extracted from unalienated Crown lands.

4.24 Newsprint industry

The newsprint industry in Newfoundland is currently comprised of three mills with a combined capacity of 663 530 metric tonnes. Newsprint production of 562 294 tonnes in 1983 represents softwood consumption of approximately 1 547 600 m^3. More specific details on each mill is provided below:

i) Abitibi-Price, Grand Falls

This mill began production in 1909 and has gradually expanded capacity from 27 000 tonnes to the current 247 000 tonnes. Newsprint production in 1983 was 187 748 tonnes, representing 76% capacity utilization and softwood consumption of approximately 523 800 m^3.

While the mill is old, capital improvements have been undertaken in the past. Future modernization has been planned, however, the decision to proceed is contingent on market conditions. Forecasting assumptions to the year 2040 are:

	Optimistic	Moderate	Pessimistic
a) capacity utilization (%)	96	91	85
b) annual growth in consumption (%)	1.0	0.5	0
c) conversion efficiency (m^3/tonne newsprint)	2.54	2.79	3.06

Wood requirements over the next rotation will continue to be supplied from the company's tenured lands.

ii) Abitibi-Price, Stephenville

The conversion of the Stephenville mill from kraft linerboard to newsprint was completed in 1981. Current mill capacity is 150 780 tonnes. Newsprint production in 1983 was 143 248 tonnes, which reflects 95% capacity utilization and softwood consumption of approximately 337 500 m^3. This mill is the most efficient of the three mills in Newfoundland with labour input per tonne of newsprint roughly one-half the rate for the Grand Falls and Corner Brook mills. Assumptions regarding long-term trends are:

	Optimistic	Moderate	Pessimistic
a) capacity utilization (%)	98	94	90
b) annual growth in consumption (%)	1.0	0.5	0
c) conversion efficiency (m^3/tonne newsprint)	2.25	2.48	2.73

The mill is assumed to continue using an input mix of 95% roundwood and 5% purchased kraft pulp. Roundwood requirements will continue to be extracted from unalienated Crown lands.

iii) Corner Brook Pulp and Paper Ltd.

The Corner Brook mill began operating in 1925 with a capacity of 127 000 tonnes. Capacity increased over time to 368 300 tonnes in 1981. In 1982 however, the mill's largest newsprint machine was permanently shut-down, leaving current capacity at 265 750 tonnes. More recently

the company announced its plan to either sell or permanently close the mill by the end of 1984. Forecasting the future status of this mill is obviously quite difficult. The only realistic option to consider is that the facility will be sold in conjunction with Government financial assistance for modernization. The regional socio-economic problems and political pressures associated with mill closure do not allow this option to be considered.

The Corner Brook mill consumed approximately 686 300 m^3 of softwood in 1983. A newer, more modern facility will likely be of a smaller capacity and greater efficiency. Three possible mill options are used in forecasting future softwood requirements. The operation of the new or reconstructed facility is assumed to begin in 1988. The long-term trends for capacity utilization, wood consumption and conversion efficiency associated with the Stephenville mill are applied to each of the three potential mill capacities for Corner Brook. These are 300 000 tonnes, 250 000 tonnes and 200 000 tonnes.

4.3 Consumption Estimates

Appendix 1 provides a listing of consumption estimates to the year 2040. Table 5 summarizes the high, low and moderate values for each year evaluated. Figure 1 presents a graphical representation.

Table 5. Forecast softwood requirements in Newfoundland to the year 2040.

Estimated requirements for 1983	Estimate range	Forecast Requirements (m^3)			
		1990	2010	2020	2040
2,385,125	High	2 582 002	3 060 359	3 360 123	4 055 555
	Moderate	2 444 436	2 681 418	2 808 912	3 083 461
	Low	2 317 331	2 367 174	2 383 369	2 416 994

The estimates indicate a wide variance, reflecting the adjustment of assumptions in the forecasting model. These data will be used in the following chapter which evaluates the economic impact of budworm damage, including effects on long-term wood supply versus demand.

5.0 ECONOMIC IMPACT OF DAMAGE

5.1 Background

On a broad Provincial basis, there will be a mixture of short and long-term economic impacts arising from spruce budworm damage since 1972. Short-term impacts refer mainly to costs incurred during the outbreak such as protection costs, increased harvesting expenses for salvage operations and the value of lost growing stock. Long-term impacts basically address the question of adequacy of future wood supplies in relation to forecast consumption. On a regional basis, one should evaluate the impact of budworm damage on specific products such as sawlogs or pulpwood. Such an evaluation could identify potential wood supply problems for specific industries or mills.

5.2 Short-Term Impacts

5.21 Loss of growing stock

Of the 50.8 million m^3 of damaged stands over the period 1972 to 1983, approximately 33.8 million m^3 is realistically available for salvage. Therefore, 17.0 million m^3 of timber were "lost" over the 11 year period. From this volume, 5.6 million m^3 were salvaged, with 6.4 million m^3 lost through blowdown and 0.6 million m^3 burned. In terms of assessing timber actually "lost" through budworm, only the 6.4 million m^3 blowndown can be considered. One must assume the burned timber would still have been burned with or without budworm damage. The timber salvaged can be thought of as "saved", albeit at higher logging costs.

Determining the value of "lost" timber is difficult for several reasons. First, while stumpage rates exist in Newfoundland, they are legislated values and bear little relation to the true economic rent of the timber. Determining the economic rent for pulpwood and sawlogs in the Province is beyond the scope of this paper. Indeed, such an evaluation would constitute a major study in itself. Therefore, the legislated stumpage rates are used to value timber in this report while recognizing they are likely low estimates compared to the true economic rent.

Second, stumpage is not charged to pulpwood harvested by the newsprint mills at Corner Brook and Grand Falls from company limits. Therefore, pulpwood damaged and not utilized on these areas doesn't represent lost revenues to the Crown since these revenues would not have been paid. This reasoning has merit, but fails to recognize that

the timber will have some implicit value, even if only to the industry. For this study, pulpwood on tenured areas is assumed to have a value to the firm equal to that of Provincial stumpage rates. Domestic fuelwood is assigned a value equal to commercial fuelwood in the same manner.

Third, foregone timber values can only be included in the analysis if the damaged fibre would actually have been used prior to deterioration. If there is no demand for the fibre, then the values "lost" through budworm damage would be low or negligible (Sinden and Worrell, 1979). This theory applies mainly to commercial timber areas. In regions of high demand for recreation, the non-timber values of forest resources may exceed those for commercial timber harvested under conditions of constrained rotation and extraction (Hyde, 1983). These non-timber values are difficult to quantify however.

The 6.4 million m^3 of merchantable timber lost over 11 years represents enough volume to supply domestic and industry for a period of only 2.7 years. Therefore, a reasonable assumption is that most of this fibre could have been utilized during the period 1972 to 1983. The simplest method of applying a value to this timber is to group the fibre by consumptive product and assign the appropriate stumpage value (Table 6).

Table 6. Value of lost timber resources in Newfoundland from 1972 to 1983.

Product type	% of Annual softwood consumption[1]	Grouping of timber lost 1972-1983 (m^3)	Stumpage values, 1983 ($/$m^3$)[2]	Total value of lost timber resource ($)
Sawlogs	8.0	513 760	2.62	1,346,051
Fuelwood	25.0	1 605 500	0.90	1,444,950
Miscellaneous	2.0	128 440	2.62	336,513
Pulpwood	65.0	4 174 300	1.80	7,513.740
Total	100.0	6 422 000	-	10,641,254

[1]Based on 1983 consumption from Chapter 4.

[2]Source: Appendix C. Values are averages between rates where access is provided and those where access is not provided.

The $10.6 million is only an approximate value of budworm damaged timber lost during the period 1972 to 1983. An implicit assumption is that the 6.4 million m^3 of damaged timber would have blown down in one year. Realistically, the fibre would be lost over a period of years from 1972 to 1983 with a corresponding flow of lost values. However, this type of approach requires more detailed information and additional assumptions which would complicate the analysis yet provide only marginally improved estimates.

5.22 Cost of salvage programs

In response to massive spruce budworm damage since 1972, intensive salvage has been undertaken both by industry and government. Industry programs centre around the harvesting of damaged pulpwood stands. Government programs involve clearing mainly non-commercial sites as a first step in rehabilitation into managed forests. For the period 1972 to 1983, a total of 5 624 000 million m^3 of damaged fibre were salvaged. More than 656 000 m^3 were salvaged through government programs with the remainder salvaged through company operations.

i) Government salvage operations

Government salvage operations have occurred since 1977, first through the Forestry Subsidiary Agreements (FSA) and later through the labour intensive Forest Economic Stimulation Program (FESP)[1]. These activities are cost shared between the Federal and Provincial Governments at a 90 (federal) - 10 (provincial) split. Up to 1983, approximately 9300 ha of budworm damaged timber were cleared under both FSA and FESP (Table 7).

The total expenditure figure is somewhat misleading since various years are used in compilation. By applying appropriate index rates to annual expenditures, total costs in 1982 dollars can be calculated (Table 8). The rate used to adjust expenditures to 1982 dollars is the National Accounts Implicit Price Index - Government Expenditure (1971-1983)(Table 8, Appendix D).

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[1]Technically, FESP is an amendment to FSA, but is considered a separate program.

Table 7. Stand reclamation funded by government programs in Newfoundland from 1977 to 1983.[1]

Year of operation	FSA		FESP		Total	
	Area (ha)	Cost($)	Area (ha)	Cost($)	Area (ha)	Cost($)
1977	414	340,746	-	-	414	340,746
1978	654	394,168	-	-	654	394,168
1979	457	302,325	722	783,379	1,179	1,085,704
1980	417	300,400	1,393	2,151,754	1,813	2,452,154
1981	659	760,323	1,517	2,658,849	2,176	3,419,172
1982	89	117,826	1,109	1,848,800	1,198	1,966,626
1983	597	830,000	1,271	1,515,020	1,868	2,345,020
Total	3,287	3,045,788	6,012	8,957,802	9,299	12,003,590

[1]Source: a) Evaluation Committee Reports; FSA and FESP, Various years.
b) Provincial Dept. of Forest Resources & Lands, 1981.

Table 8. Adjusted total costs, government funded salvage operations in Newfoundland from 1977 to 1983 in 1983 dollars.

Program	Total Cost (1983 $)	Area (ha)	Average Cost ($/ha)
FSA	3,735,200	3287	1,136
FESP	10,244,520	6012	1,704
Total	13,979,720	9299	1,503

The $14.0 million represents the opportunity cost of government salvage operations on 9299 ha of budworm damaged stands. In other words, if budworm damage had not occurred, these funds could have been employed in other programs, perhaps yielding higher returns.

The net cost to government is less than $14.0 million since a portion of the wood was sold as pulpwood with revenues flowing to the Crown. There is limited published data however, on the amount of salvaged wood actually sold, or for what prices, for every year.

ii) Industry salvage programs

Deducting government salvage wood (656 000 m^3) from total salvage wood indicates the newsprint companies harvested 4 968 000 m^3 of budworm damaged fibre up to the end of 1983. The newsprint mills generally restrict salvage fibre to 40% of mill input to maintain paper quality. There are several costs associated with company salvage operations. First, higher extraction costs will result through increased breakage of brittle wood during falling and skidding. Second, costs of harvesting in stands with even moderate blowdown present, will be higher than in normal operations. The 1981 Royal Commission Report (Poole et al.) estimated that logging costs could increase by up to 20% if company operations cut 60% of their pulpwood from damaged stands. Assuming that 40% of mill input is damaged fibre, logging costs could conceivably be 15% higher than normal. In support of this assumption, Bowater Newfoundland experienced a 31% decline in wood production per man-day from 1976 to 1980 in deteriorating stands damaged by budworm (Poole et al., 1981).

Using the estimates of 5.0 million m^3 salvage volume and a 15% increase in logging costs, one can derive a cost value due to salvage harvesting by the companies. While no published data on Newfoundland logging costs per m^3 are available, indirect estimates can be developed. A report on Canadian wood costs (Peat, Marwick and Partners, 1977) indicated pulpwood logging costs in 1976 to be approximately $50 per cunit. Adjusting these costs in view of local characteristics in Newfoundland reduces this figure to $43 per cunit, or $15 per m^3. To estimate wood costs in 1983, the 1976 value was adjusted using the National Accounts Implicit Price Index, Goods and Services (1971 = 100). The cost per cunit in 1983 dollars for Newfoundland is an estimated $79, or $28 per m^3. Adding a 15% cost factor for salvage logging results in an extra cost of $4 per m^3. Therefore, using the 5.0 million m^3 volume salvaged, the additional logging costs imposed on company operations was an estimated $20 million in 1983 dollars. This figure should not imply that all salvage cutting occurred in 1983. The 5.0 million m^3 of salvage wood was harvested over a five to six year period beginning in the mid 1970's.

Processing costs will also increase as a result of using deteriorated fibre for mill furnish. During debarking, any decayed

fibre on the outside of the bole will be lost, thus reducing pulping yields. In addition, using deteriorated fibre during processing will produce lower quality paper. As the percentage of saprot and advanced rot per unit of wood input is increased, yield, paper strength and brightness will decline while opacity increases (Hudak and Basham, 1981). To alleviate these problems, higher costs must be incurred such as using more chemicals such as brightners, or adding purchased kraft pulp to mill input. Given the intense sales competition for newsprint markets, only the highest quality paper will be sold.

A further cost associated with salvage operations is the lower stumpage rate assessed for budworm damaged timber. The difference in stumpage rates between salvaged and healthy timber averages \$0.83 per m^3 for pulpwood. Assuming all salvage wood during 1972 to 1983 was pulpwood, the potential lost stumpage value was \$4.6 million based on 5.6 million m^3 salvaged. The inclusion of salvaged sawlogs into the anlysis would alter the magnitude of lost stumpage values, however, no specific volume data are available.

5.23 Volume losses and salvage costs - post 1983

Of more concern is the loss of growing stock from the volume available for salvage in 1983. Of the 33.8 million m^3 available in 1983, 13.6 million m^3 or 40% of total stand volume were in the dead and dying classes. The 33.8 million m^3 represents nearly 14 years wood supply for all consumption sectors in the province. Obviously, not all this fibre will be, or can be salvaged prior to deterioration and blowdown. There are limits on the quantities which can be used for sawlogs, newsprint or fuelwood based upon final product quality, harvesting economics and logging safety. Generally, five years from mortality is an acceptable limit for utilizing budworm damaged fibre.

Estimates of volumes lost from 1983 to 1988 can be developed by using current wood requirements and the five year time limit for salvage operations. The following assumptions refer to the quantity of salvage wood which could optimistically be consumed each year by various users (Table 9).

The low salvage percentage for sawmills reflects the reluctance of mills to use dead or dying sawlogs for lumber production. The newsprint industry could optimistically utilize 45% budworm damaged fibre compared to the current 40%. For domestic fuelwood, one could expect 100% utilization of damaged timber, however, cutters will continue harvesting the most easily accessible stands, irregardless of condition. Given the current problems in controlling domestic cutting, even an 80% salvage figure is optimistic. The miscellaneous salvage

figure of 10% reflects the high strength requirements for many products such as wharf timber and mine props.

Table 9. Estimates of annual salvage volumes by user groups in Newfoundland.

Softwood user group	Consumption 1983 (m^3 solid)	Estimated % salvageable	Estimated volume salvageable (m^3 solid)
Sawmill industry	192 600	20	38 520
Newsprint industry	1 547 600	45	696 420
Domestic fuelwood	596 925	80	477 540
Miscellaneous	48 000	10	4 800
Total	2 385 125	51	1 217 280

Assuming the estimated annual salvage volumes remain constant over a five-year period after 1983, aproximately 6 086 400 m^3 will be utilized. Therefore, 27.7 million m^3 of damaged softwood stands, occupying 291 000 ha will remain unsalvaged. In the absence of new markets for this wood, such as export pulpwood, this fibre will deteriorate, blow down, and be lost from the Provincial forest inventory.

There are two monetary impacts which can be quantified: 1) costs of company salvage logging and 2) costs of government salvage logging. In both cases, the major product being salvaged is pulpwood. Of the 45% of annual pulpwood requirements, 40% is assumed to originate from company operations and 5% from government salvage programs. The 5% figure closely follows historical trends since the late 1970's. Applied to the estimated 696 420 m^3 of pulpwood salvaged annually, company and government operations will harvest 619 040 m^3 and 77 380 m^3 respectively.

For company salvage operations, an additional harvesting cost of $4 per m^3 was estimated earlier. For the analyses, these costs are assumed to remain constant in real terms from 1983 to 1988. Using a real discount rate of 3%, the present value of the incremental costs in 1983 dollars is approximately $11.3 million.

For government salvage operations, the annual harvest of 77 380 m^3 translates into 1290 ha per year, using an average salvage volume of 60 m^3 per ha. Assuming 1983 reclamation costs of $1,503 per ha are maintained in real terms from 1983 to 1988, the present value of these expenditures in 1983 is $8.9 million using a real discount rate of 3%.

A third cost to consider is lost stumpage values since the stumpage rate charged for salvage wood is $0.83 per m^3 less than for non-damaged commercial stands. Applied to the 696 420 m^3 of pulpwood salvaged annually over 1983 to 1988, the present value of this foregone stumpage is $2.6 million.

Most important is how to evaluate the 33.8 million m^3 of salvageable damaged stands that will not be salvaged. As explained earlier, the values lost are minimal if the non-utilized fibre would not have been harvested without budworm damage. While placing a value on this "lost" fibre is difficult, the cost of rehabilitating these sites can be estimated. To clear 291 000 ha using stand reclamation would involve a massive long-term commitment of resources. Assuming these areas were treated over a period of one rotation or 60 years, 4850 ha per year would be reclaimed each year. The annual cost of treatment, even at $1,000 per ha would be $4,850,000. The present value of these expenditures for a 60 year period, in 1983 dollars is approximately $134 million. This figure represents a maximum value since not all sites will be accessible nor desirable to reclaim. In addition to clearing, a certain proportion of these sites would require some combination of silvicultural prescriptions at varying costs. No reasonable estimates regarding the type and cost of reforestation can be developed at this time. One can only recognize these costs as potential impacts from budworm damage during 1972 to 1983.

5.24 Cost of chemical protection

The cost of protecting the forest resource through chemical spray programs is a direct impact of the budworm outbreak. The use of aerial chemical spray programs has varied considerably in Newfoundland. An experimental program was first initiated in 1977 using several spray formulations. A large operational program was undertaken in 1978, however, activities were drastically reduced in the following two years due to public pressure related to health concerns. To alleviate this problem, the Provincial Government established a Royal Commission to address the question of an aerial spray program in relation to the budworm outbreak. Following recommendations in the subsequent report (Poole *et al.*), a large protection program was again undertaken in 1981.

For the period 1977 to 1983, approximately 1 405 000 ha were sprayed with several insecticides and the biological control agent B.t. The total cost in 1983 dollars of aerial spray operations was an estimated $15.8 million (see Appendix E). Insect protection programs have continued since 1983 in response to recurring budworm populations in various regions of the Province and are likely to continue in future years. At this time, however, there is simply no way to estimate the time horizon, magnitude and cost of future spray programs.

5.25 Intensive management programs

A side effect caused by the spruce budworm has been the acceleration of intensive silviculture programs to a) reforest reclaimed salvage areas and, b) increase yields through reforestation of nonsalvage logged areas, and stand improvement in existing forests. These programs were initiated on a broad scale in 1974 through the funding of a $55 million cost-shared Federal/Provincial Forestry Subsidiary Agreement. This five year Agreement was followed by a similar Agreement in 1981 with a $52 million funding level. In addition, a series of two labour-intensive, cost-shared programs have contributed towards intensive silviculture since 1979 with total funding of approximately $20 million. In addition to silviculture, a major access road program has been funded through these Agreements. The objectives of these roads centre on providing access for budworm timber salvage and intensive silviculture programs. For the period 1974 to 1983, approximately $20.0 million were spent on intensive silviculture programs. Examples of specific program elements include construction of a tree nursery, site preparation, reforestation and stand improvement. Under access roads approximately $26.8 million was spent to the end of 1983 on road construction and upgrading. Therefore, total expenditure under both programs was $46.8 million.

The exact proportion of these expenditures arising directly because of the budworm outbreak is difficult to identify. On the one hand, virtually all of these expenditures can be rationalized in terms of providing access for salvage or silviculture, or to alleviate possible fibre shortages in the future. On the other hand, the Province may have initiated much of this activity to increase future yields even without a budworm problem. An evaluation of the objectives of each individual Forestry Agreement suggests these programs were strongly influenced by the budworm outbreak and the threat of future supply deficits. However, the 1972 Federal-Provincial Task Force on Forestry (1973) recommended implementation of forest improvement and access

road programs to expand forest productivity and increase operating efficiency. Therefore, one cannot determine the proportion of the $46.8 million in expenditures which are direct costs arising from the budworm outbreak. The $46.8 million figure should simply be viewed as a maximum potential cost.

5.26 Additional impacts

There are many additional economic impacts directly caused by the spruce budworm damage during the period 1972 to 1983. These impacts are difficult to quantify due to a lack of data, however, they are listed below for information.

i) Growth losses

Long-term infestation and defoliation causes reduction in increment and cessation or reduction in height growth. The level of reduced growth is directly related to the severity and duration of defoliation (MacLean, 1981). Studies which quantify growth losses have been conducted in Maine and New Brunswick, however, no detailed data are available for the Newfoundland outbreak. The major impact of reduced growth is lower stand volumes at maturity. Therefore, in addition to the lost increment volume which can be valued at current stumpage rates, average harvesting costs at maturity will be higher due to reduced volumes.

ii) Loss of seed

In a severe budworm outbreak, black spruce flowers are susceptible to damage, thus reducing the formation of mature cones. Major reductions in cone production can greatly limit the quantity of seed available for seedling production (Schooley, 1981). A potential economic impact is higher seed procurement costs, either through cone collection programs or to purchase seed. The budworm outbreak in Newfoundland has made cone collection programs more difficult for black spruce seed over the past decade. While seed procurement goals have been achieved, progress was slow. The economic costs arising from the impact of budworm damage cannot be estimated.

iii) Environmental and aesthetic impacts

The environmental impact of spruce budworm damage is extremely difficult to quantify. Case and Raske (1981) indicated that impacts on fish and wildlife habitat may in fact be positive due to increased browse production as the fir overstory is defoliated and opened up. A spruce budworm outbreak is a natural phenomenon; thus wildlife will

gradually adapt to the changing forest structure. Aesthetically, however, the impact of a serious budworm outbreak are clearly negative. Aesthetic values associated with recreational use of the forest will decline as fir stands turn reddish-grey and are windthrown (Case 1981). No data are available to quantify any economic impacts such as reduced tourism revenue or damage to Christmas trees.

5.27 Summary of short-term economic impacts

This chapter has provided estimates of the major economic impacts arising from the recent spruce budworm outbreak. These impacts were quantified where possible, for the period 1972 to 1983 with the exception of short-term volume losses and costs of salvage operations. These latter two impacts were estimated to 1988. All costs were described in present value terms, in 1983 dollars. Table 10 summarizes the results of section 5.2.

Table 10. Summary of short-term economic impacts of spruce budworm damage.

	Economic impact	Estimated cost (1983 dollars)
1.	Value of lost growing stock 1972-1983	10,641,000
2.	Cost of Gov't. salvage programs 1972-1983	13,980,000
3.	Cost to industry for salvage logging 1972-1983	20,000,000
4.	Lower stumpage values on salvage timber 1972-1983	4,600,000
5.	Cost of Gov't. salvage programs 1983-1988	8,900,000
6.	Cost of industry for salvage timber 1983-1988	11,300,000
7.	Lower stumpage values on salvage logging 1983-1988	2,600,000
8.	Chemical protection program 1977-1983	15,800,000
	Total Estimated Impact	87,821,000

From Table 10, an estimated $65,021,000 are economic costs occurring during the 11-year period, 1972 to 1983. The remaining $23 million are costs associated with salvage operations over a five-year period from 1983. This time period corresponds to the number of years that stands damaged up to 1983 can effectively be utilized.

Not included in Table 10 are two major economic impacts. These are the cost of intensive management programs during 1972 to 1983 and the cost of reclaiming damaged stands not salvaged by 1988. Up to the end of 1983, expenditures on intensive silviculture and access road programs were approximately $46.8 million. Potential costs of reclaiming approximately more than 5000 ha of damaged stands annually

over one rotation could approach $140 million (present value, 1983). These two impacts are maximum values and may not reflect the true costs arising from the budworm outbreak. However, in conjunction with costs shown in Table 10, these two impacts reflect the severity of the budworm damage in Newfoundland.

5.3 Long-Term Impacts

5.31 Effect on wood supply

Over the short-term, a serious budworm outbreak may not create softwood timber deficits. In forests with a predominant overmature age class, the supply of available timber can actually increase as efforts are made to salvage damaged stands prior to severe deterioration. Heavy losses in softwood stands, even for a short period of time, can create future fibre deficits once the "salvage glut" has passed. In Newfoundland, concerns have been raised about the adequacy of future softwood supplies for the Island. The 1981 Royal Commission Report (Poole et al.) identified a softwood deficit in relation to fibre requirements of nearly 900 000 m^3 by the year 2020.

The Royal Commission forecast used only one projection of wood requirements. As explained in chapter 4 of this report, wood requirements have changed considerably, given updated information on fuelwood consumption and the uncertain future of the Corner Brook newsprint mill. To obtain a broad comparison of long-term softwood requirements (demand) with AAC (supply) updated consumption forecasts from chapter 4 are compared with AAC projections from the Royal Commission Report (Figure 2).

Assuming actual wood requirements falls in between the optimistic and moderate projections, softwood deficits could appear during the period 2008 to 2024. Under pessimistic projections of wood consumption, no softwood deficits are likely. Also, the AAC projection in Figure 2 may not be completely accurate for several reasons. First, the projection is four years out of date. Second, the projection does not account for future increases in volumes arising from current and proposed intensive management programs. Third, recent evident black spruce mortality is not accounted for. These latter two factors tend to offset each other, however, the degree to which they balance out cannot be determined. Therefore, the AAC projection in Figure 2 cannot be adjusted in either direction at this time.

For the Island as a whole, long-term fibre deficits are possible under specific assumptions (Figure 2). More important, however, is the impact on wood supply for the various wood consuming sectors.

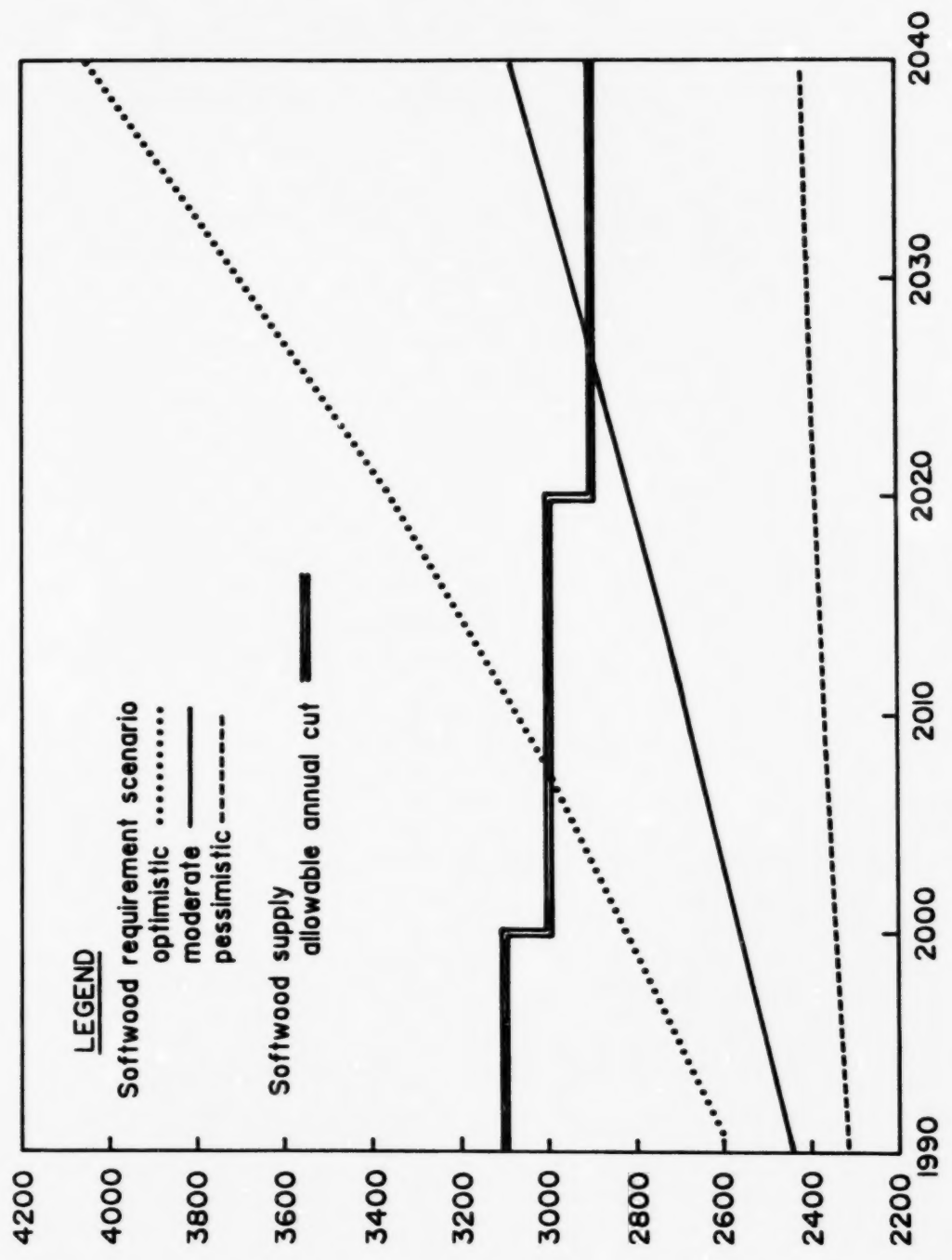

Figure 2. Comparison of long-term wood supply with projected wood requirements.

In Newfoundland, the sectors most affected by a softwood shortage would be the sawmill and newsprint industries. No current, published data are available which describe the AAC for sawlogs and pulpwood, either on a provincial or regional basis. Therefore, specific impacts for a specific industry or region cannot be determined. Only a general qualitative analysis is possible at this time.

i) Sawmill industry

The sawmill industry is currently experiencing problems in finding adequate volumes of high quality sawlogs. This problem was evident in 1981 and appears to be a growing concern among mill owners, especially in eastern Newfoundland (Milne, 1984). Spruce budworm damage is the main cause, with lack of access and overcutting, acting as contributing factors in certain regions. The majority of damage to sawlog supplies has probably already occurred. As the existing damaged stands deteriorate, availability of quality sawlogs will continue to decline in most areas of unalienated Crown land. Mills have adapted to using smaller diameter sawlogs but at reduced profitability. The industry itself has shown signs of structural changes. From the period 1979/80 to 1982/83 the number of mills producing between 237 m^3 to 1180 m^3 (100 000 to 500 000 fbm) annually, decreased from 82 to 14. For the same period, the number of large mills producing more than 1180 m^3 (500 000 fbm) annually declined from 14 to 7. During this period, the number of sawmills actually increased from 1603 to 1781, however, the expansion occurred in smaller mill classes. These small mills are mainly seasonal operations with low employment and average incomes. The economic benefits derived from the industry will be reduced as production continues to shift from larger full-time mills to small part-time operations.

A second impact of increasing scarcity of sawlog resources is the likely decline in lumber production. Newfoundland sawmills generally supply 40% of the domestic lumber market with minor fluctuations in any given year (Milne, 1984). Reductions in local production could arise through an inability to compete with imports due to higher costs in harvesting scarce sawlogs and in milling smaller diameter logs. As a result, the Provincial dependence upon imported lumber should increase.

ii) Newsprint industry

As shown in earlier chapters, the newsprint industry is the largest consumer of softwoods and the major contributor to forestry generated employment and income. Any long-term reduction in wood supply could have serious implications on a mill's ability to produce newsprint

at competitive costs. Newsprint mills must operate at or near full production capacity to generate a return above high fixed and variable costs. Sustained operation at less than full capacity is not economically feasible and would ultimately lead to lay-offs and possibly mill closure. Munro (1981) estimated that a 20% reduction in industrial activity could result in the loss of 980 jobs, annual incomes of $21 million and value added of $50 million. These impacts would only be the direct effect. Reductions in local industry and employee expenditures would lead to a decline in the indirect benefits generated. Using an industry multiplier of 3.00 would mean that a loss of 980 jobs in the newsprint industry could reduce indirect employment in supporting sectors by nearly 2,000 people.

Mill closure even for a short time period would have a devastating economic impact on the immediate community and the Province as a whole. Each of the three newsprint mills provide the economic mainstay for a separate community. As an example, the mill in Grand Falls employs more than 20% of the local labour force in the town itself and surround communities. Including indirect employment, mill activity is responsible for more than 60% of the local labour force. Similar situations exist in Stephenville and Corner Brook.

There is currently a wide range of opinion regarding the stability of long-term wood supply for each of the newsprint mills. To fully assess the situation, a detailed study of future wood requirements versus AAC should be conducted. This gap in information is a serious constraint to long-term resource planning which must be addressed.

5.32 Constraints to industry expansion

An important impact to consider is the effect of budworm damage on long-term resource development, specifically expansion of the forest industry. While current opinion differs as to the timing and magnitude of future softwood deficits in Newfoundland, most professional foresters agree that wood supply will restrict major future industry expansion. The main goal of Provincial forest management programs is to maintain economic wood supplies for the existing industry structure on the Island (Anon., 1984). While the forest land base may be large enough to sustain a fourth pulp and paper mill or expanded sawmill activity, the timber volumes on this land are inadequate due to budworm losses. Given sufficient funds, current intensive management programs could increase future yields to enable industry expansion after one rotation period (50 to 70 years). However, the information base and analytical tools in the Province are not sufficiently developed to allow the necessary long-term planning to occur.

5.33 Environmental - aesthetic impacts

The short-term environmental and aesthetic impacts have been discussed earlier. A remaining question is the longer-term effects of budworm damage. Specifically, what will happen over time to damaged stands which are not salvaged? For stands which are eventually cleared-off and reforested, commercial forests will result after one rotation. Research by Meades (1981) suggests that a large proportion of budworm damaged stands not reclaimed will eventually develop into Kalmia heath or hardwood vegetation. These successional patterns will ultimately reduce the long-term supply of commercial softwoods on the Island.

Aesthetically, recreational values on these areas will continue to decline in the long term. As stands suffer considerable blow-down, the risk of fire will become an increasing concern during periods of sustained dry weather. An associated impact may be higher fire detection and suppression costs.

6.0 CONCLUSION AND RECOMMENDATIONS

While the scale of the Newfoundland forest industry may not be as large as in some other provinces such as British Columbia or Quebec, the industry is vitally important to the Provincial economy. The forest industry in Newfoundland provides approximately one quarter of all manufacturing employment and income. Indirect employment and income generated mainly in petroleum, service and supply sectors, further strengthen the importance of the forest industry in Newfoundland.

The recent spruce budworm outbreak which began in 1972 poses a serious threat to the maintenance of a healthy, competitive forest industry and the associated economic benefits. From 1972 to 1983, approximately 484 300 ha or roughly 13% of the productive forest on the Island were damaged by the budworm. The total volume of merchantable softwoods on this area is approximately 50 million m^3. The dead component of this volume is 23.1 million m^3. Up to 1983, 5.6 million m^3 of the 50 million m^3 damaged had been salvaged. After deducting losses from blowdown and fire, 38.2 million m^3 remain to be salvaged.

The economic costs associated with the budworm outbreak from 1972 to 1983 were an estimated $65.0 million. These costs include the value of lost growing stock, costs of salvage logging and chemical protection programs and reduced stumpage revenues for salvage timber. The costs of salvaging deteriorating stands over a five year period to 1988,

including lower stumpage values are an estimated $23.0 million, in 1983 dollars. Therefore, total economic costs associated with the current outbreak are an estimated $87.8 million in 1983 dollars.

Additional costs which can be considered are intensive management costs from 1972 to 1983 and potential costs of rehabilitation damaged areas over the next rotation. These costs are an estimated $46.8 million and $140 million respectively. The magnitude of these costs reflect the severity of the budworm damage.

Longer-term impacts are more difficult to assess, however, these are more critical than the impacts to 1982. The question of long-term wood supplies was difficult to address. Forecasts of future softwood requirements were made in this study and indicate that wood requirement in the year 2040 could range between 2.4 million m^3 and 4.1 million m^3 depending upon the assumptions used. The only available published data on future AAC for the Island indicate a long-term supply in the 3.0 million m^3 range. This forecast is out of date and should be revised to enable a better comparison of long-term wood supply.

In terms of specific products, quality sawlogs will likely continue to become a scarcer commodity with serious impacts on the sawmill industry. The scale of the industry will likely decline in addition to seeing production shift from larger full-time mills to smaller seasonal operations. If shortages of economically available pulpwood emerge in the next rotation, the impact on the newsprint industry could take the form of higher wood costs, reductions in capacity or even mill closure. A shutdown of one of the Island's three newsprint mills would have devastating economic and social implications for the community affected and the entire Province.

While there are uncertainties in identifying the existence, magnitude and timing of future softwood deficits, the wood supply situation will most likely prevent major expansion of the forest industry in the next rotation. This constraint will increase the Island's dependence on imported lumber and prevent expansion of newsprint capacity. Given the lack of alternative resource development opportunities in the Island's interior region constraints on expanded forestry activity represent a major economic loss.

The long-term environmental and aesthetic costs associated with the budworm outbreak are difficult to quantify. In general terms, damaged areas not rehabilitated will suffer aesthetic degradation thus lowering any values related to recreational use. The long-term successional pattern on many of these areas may be towards a Kalmia heath or hardwood vegetation. This trend has serious implications regarding the long-term Provincial forest base.

During the course of this study, several information gaps were evident. These deficiencies must be corrected to allow a more thorough analysis on potential long-term softwood deficits. The most critical impact of the recent spruce budworm outbreak may be the effect on wood supply over the next rotation. The problem must be viewed in three ways; 1) on a broad provincial scale; 2) on a regional or management unit basis; and 3) by specific forest product. This current study considered the first and third approaches to the extent that limited information and time permitted. A more detailed analysis is required. Perhaps of most concern is the regional analysis of long-term wood supply compared to forecast requirements.

To address this problem, there are a series of recommended steps for industry and both levels of government to consider.

1) Development of a computer simulation model to predict future yields and AAC. The model should incorporate assumptions regarding yields from intensive management programs and losses from fire, insects, disease and man. The Department of Forest Resources and Lands should act as the lead agency in this endeavor.

2) Formation of a committee comprised of officials from industry, the Provincial Department of Forest Resources and Lands and the Federal Canadian Forestry Service. The committee would be charged with responsibility to develop and agree upon the many assumptions required to utilize the model. A further task would be to develop projections of future softwood requirements for specified products.

3) Trial runs of the model with output reviewed by the committee and revisions made as necessary.

In this manner, long-term forecasts of softwood supply versus predicted consumption could occur. Ideally, this analysis should be conducted on a management unit basis for specific products. Future supply/demand trends could be identified by region, product magnitude and timing. Aside from the benefits of providing an information base for long-term planning, the future impacts of budworm damage could be more easily quantified.

Another major information gap is the lack of data on growth losses due to budworm damage. These losses could collectively be quite significant in terms of their economic impact. Further research in a Newfoundland context is required.

More research on the long-term environmental and aesthetic impacts from the recent budworm outbreak is also needed. The ultimate successional pattern which emerges on currently damaged stands could have major implications with respect to long-term wood supply and costs of rehabilitation. In terms of aesthetic damage, the potential impacts on recreational values could be evaluated in a separate study.

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APPENDIX A

Cumulative areas and volumes of merchantable stands with tree mortality caused by the spruce budworm in Newfoundland by 1983.

	Total area(ha)	Dead volume(m^3)	Dying volume(m^3)	Total stand volume(m^3)
1) Cumulative Area to 1983				
Balsam fir	388 700	19 905 000		40 441 000
Black spruce	95 700	3 194 000		10 322 000
Total	484 400	23 099 000	-	50 763 000
2) Salvage by 1983				
Balsam fir	45 300			4 212 000
Black spruce	14 400			1 412 000
Total	59 700	-	-	5 624 000
3) Burned by 1983				
Balsam fir	6 100			562 000
Black spruce				
Total	6 100	-	-	562 000
4) Blow down by 1983				
Balsam fir	56 700			5 762 000
Black spruce	6 600			660 000
Total	63 300	-	-	6 422 000
5) Stands existing in forests in 1983				
Balsam fir	280 500	12 200 000	1 984 000	29 905 000
Black spruce	74 700	2 766 000	915 000	8 250 000
Total	355 200	14 966 000	2 899 000	38 155 000
6) Stands still salvable in 1983				
Balsam fir	280 500	8 150 000	1 984 000	25 855 000
Black spruce	74 700	2 510 000	915 000	7 994 000
Total	355 200	10 660 000	2 899 000	33 849 000

APPENDIX B

Softwood Requirements for Newfoundland to the Year 2040.

Scenario	1990	2010	2020	2040
Optimistic				
1	2 542 132	3 060 359	3 360 123	4 055 555
2	2 429 731	2 923 209	3 208 624	3 870 697
3	2 317 331	2 786 059	3 057 125	3 685 839
Moderate				
1	2 562 173	2 822 504	2 945 652	3 234 544
2	2 444 436	2 681 418	2 808 912	3 083 461
3	2 326 699	2 551 331	2 672 172	2 932 378
Pessimistic				
1	2 582 002	2 613 207	2 629 403	2 663 028
2	2 348 986	2 390 191	2 506 386	2 540 011
3	2 335 969	2 367 174	2 383 369	2 416 994

where 1 = 300 000 tonne mill in Corner Brook by 1988
2 = 250 000 tonne mill in Corner Brook by 1988
3 = 200 000 tonne mill in Corner Brook by 1988

volumes in m^3 solid

APPENDIX C

Newfoundland Stumpage Rates, 1983/84.

Product	Access road provided by Province	No access road provided	Average rate
1. Pulpwood			
a) Salvage wood ($/m^3)	1.20	0.75	0.98
b) Non-salvage ($/m^3)	2.40	1.20	1.80
2. Sawlogs (softwood) ($/m^3)	3.05	2.18	2.62
3. Commercial fuelwood ($/m^3)	1.10	0.70	0.90

APPENDIX D

Price Indices for Canada.

1) National Accounts Implicit Price Index, 1971 = 100 for Government Expenditure.

Year	Index (% change)
1977	9.6
1978	8.3
1979	9.1
1980	13.0
1981	14.2
1982	12.3
1983	7.7

2) National Accounts Implicit Price Index, 1971 = 100 for Goods and Services.

Year	Index (% change)
1977	7.5
1978	7.7
1979	9.3
1980	10.8
1981	11.6
1982	10.8
1983	5.9

APPENDIX E

Spruce Budworm Chemical Spray Costs for Newfoundland, from 1977 to 1983.

Year	Area Sprayed (ha)[1]	Estimated cost/ha dollars	Total cost in current dollars	Total cost in 1983 dollars[2]
1983	138 000	10.70	1,476,780	1,476,780
1982	85 000	11.70	994,500	1,053,176
1981	344 000	10.42	3,584,480	4,262,868
1980	15 000	8.00	120,000	162,976
1979	6 000	7.20	43,200	66,299
1978	737 000	6.40	4,716,800	7,897,551
1977	80 000	5.90	472,000	855,885
Total	1,405,000			15,775,535

[1]Area sprayed accounts for stands sprayed twice. Thus, if an area is treated twice, the total area sprayed equals twice the original area.

[2]Values in 1982 dollars are calculated using the National Accounts Implicit Price Index for government expenditure. See Appendix D.